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Author

Byers, Jr., F. M., W. J. Carr & P. O. Orkild

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Volcanic Centers of Southwestern Nevada: Evolution of Understanding, 1960–1988

F. M. BYERS, JR.

Los Alamos National Laboratory, New Mexico

W.

Golder

PAUL P. ORKILD

U.S. Geological Survey, Denver, Colorado

Since about 1960, geologists of the U.S. Geological Survey and, more recently, those of Los Alamos and Lawrence Livermore national laboratories, supported largely by the U.S. Department of Energy (DOE) and its predecessors, have been unraveling a complex series of ash flow sheets, lavas, and related calderas in the southwestern Nevada volcanic field in and near the Nevada Test Site (NTS). Extensive detailed geologic mapping aided in delineation of four major calderas: Silent Canyon (~14) Ma), Timber Mountain–Oasis Valley (~11.5 Ma), Black Mountain (~7.5 Ma), and Stonewall Mountain (~6 Ma). In the 1960s, key concepts that contributed to the understanding of volcanology were the recognition of vertical compositional zonation within ash flow sheets, the significance of caldera rim and moat lavas, the relation between caldera collapse and intracaldera breccias and ash flow facies, and the correlation of intracaldera and outflow-sheet facies. Deep drill holes within Silent Canyon and Timber Mountain calderas provided vital information on caldera geometry and intracaldera facies. Radiometric dating has produced nearly 100 dates that define the age of the field between about 16 and 6 Ma. During the middle part of that period a major ash flow eruption occurred once in about every half million years. Continuing support by the DOE for earth science at the NTS during the 1970s and 1980s has permitted a unique longevity of studies and provided opportunities to restudy mapped areas, revise some incorrect relationships, and work out important details of caldera history and structure that otherwise would not have come to light. Petrochemical and isotopic studies contributed to the understanding of the PT environment of the magma bodies that generated the major ash flow sheets. In the last decade, specialized work has continued on stratigraphic and petrologic problems, resulting in understanding of petrochemical cycles, in wider and more accurate correlation of certain units, and in understanding the time and spatial relationship between petrochemically very similar ash flow sheets from the Black Mountain and Stonewall Mountain calderas. Drilling and detailed Earth science studies in connection with preliminary characterization of a proposed nuclear waste repository at Yucca Mountain have greatly advanced knowledge of the older and younger parts of the volcanic sequence, including the basalts. A newly defined volcano-tectonic collapse area in Crater Flat, probably a caldera, is strikingly similar in structure, location, and geophysical expression to the Silent Canyon caldera to the north. Rhyolite lavas peripheral to the Timber Mountain–Oasis Valley caldera complex are intercalated with the major ash flow sheets from the complex, and analyses of the lavas fit well on compositional trends determined by the ash flow sheets. Renewed studies since 1981 include eruptive dynamics and magma chemistry of the major ash flow sheets and sources of mafic and intermediate volcanism. Hydrothermal alteration and mineralization occur after major magmatic pulses. New data on the age, structure, and distribution of the volcanic rocks have resulted in revised structural models involving volcano-tectonic and detachment faulting processes.

INTRODUCTION

This introductory paper is a review of past studies and the evolution of concepts on calderas and related magmas of the southwestern Nevada volcanic field during a period of protracted field, drilling, and laboratory investigations from 1960 to the present (1988). The name southwestern Nevada volcanic field was used first by *Christiansen et al.* [1977] to include the broad volcanic plateau underlain by tuffs and lavas of the Timber Mountain–Oasis Valley caldera complex and Silent Canyon and Black Mountain calderas (Figure 1). In this paper and those that follow in this special issue of the *Journal of Geophysical Research*, the southwestern Nevada volcanic fiel is expanded to include volcanic rocks from three adjacen areas: Stonewall Mountain caldera complex, a possible cal dera complex in Crater Flat, and vents near Bullfrog Moun tain west of the Timber Mountain–Oasis Valley (Figure 1 Tuffs and lavas from these outlying volcanic centers inter tongue with those from the Timber Mountain–Oasis Valle caldera complex, and together they form a dissected, dis continuous, and faulted volcanic field. The eastern part of thi volcanic field extends onto the Department of Energy (DOE Nevada Test Site (NTS).

As early as the 1950s, geologists of the U.S. Geologica Survey (USGS) began geologic mapping at the U.S. Atomi Energy Commission (AEC) Proving Grounds [*Johnson an Hibbard*, 1957], now the NTS, and conducted engineerin studies of tuffs beneath Rainier Mesa at the request of th

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